

## How to do Undergraduate Research

### A brief guide to the value of undergrads in the lab and how they can get ahead

Undergraduates are often trapped in a paradox: they need experience to do research, but entry level positions also call for experience. Undergrads must compete to give their free time to research. Usually this involves cultivating a relationship with a professor, sending countless emails, and maintaining a high GPA. If an undergraduate finds research, she will then commit hours of her week to whatever is asked of her, for example: days of pipetting and counting cells. Is the endeavor worth it? Studies and interviews with our UCSC iGEM team point to yes. Practicing research versus reading about research is like the difference between dreaming and training for the Olympics, if you have the right team to teach you.

Renne Jovic, co-founder and co-captain of the UCSC iGEM team, has searched for undergraduate research since her freshman year at UCSC. Although some professors want to wait until she gets more lab experience in classes like biochem, she's made headway by starting an iGEM team with Rolando Perez. She seems to be bobbing and weaving past the typical discouragement undergraduates feel when they apply to research.

"I've known since I was in 5<sup>th</sup> grade that I want to be a bioengineer. That hasn't changed," says Jovic.

Jocic is part of the minority of women in leadership positions in the iGEM competition. She's made relationships with not only Dr. Bernick who mentors the iGEM team, but other professors and the deans of UCSC as she reaches for the funding and assistance her team needs.

According to surveys on undergraduate research, Jocic's persistence will have enormous pay offs as she works on the iGEM team and if she finds research elsewhere. The National Science Foundation surveyed undergrads involved with research and found that 83% of the respondents felt more confident in their research skills and 68% of the respondents said they were more interested in STEM careers because of their work (Russel & Hancock & McCullough 2007).

Another study conducted in four liberal arts colleges on 10 week internships for undergraduates reports: "...more than half of faculty observations (52%) described changes they observed in students' conduct and manner, noting how students began to exhibit behaviors and attitudes that underpin research work, such as curiosity and initiative, becoming less fearful of 'being wrong,' and more willing to take risks." (Hunter & Laursen & Seymour 2007).

However, there are more students than positions. Undergrads can contribute to cutting edge research that often gets published, but teaching them in the lab takes time and energy. The rewards are not immediate, and some professors are skeptical that learning curve littered with spills and broken test tubes are worth their while.

Dr. David Bernick is not one of those professors. He often volunteers himself to mentor undergraduates.

“It’s a blast. Some of the most challenging questions that I’ve ever heard have been raised by undergrads,” says Bernick.

He’s seen undergrad research reap significant results. Past students he’s mentored have discovered giant viruses in lakes, modeled how long orangutans in Borneo have to survive, and published papers about how society treats HIV patients.

Not all research will yield such success, but Bernick has advice for those who want to try.

Cultivating a relationship with a mentor is key to finding undergraduate research. A student must be prepared to work in the lab, but a lab must also be prepared to work with the student.

Compatibility and personality are equally, if not more, important than academics and experience.

“The missing courses, many times we can make up for. I can’t make up for lack of curiosity. I can’t make up for trepidation,” says Bernick.

Bernick seeks “fearlessness” and “curiosity.” The only way he can discern these qualities, and help undergrads pursue specific interests is if the student musters the courage to knock on his door during office hours.

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Bernick and other principle investigators want to see research experience on graduate school applications because it tells them that the applicant can ask questions. If an undergrad cannot get a research position in a lab during the school year, summer internships, and field courses are valid alternatives. However, to produce good future grad students, the same principle investigators have to make undergrad research opportunities.

Scientists who go out of their way to teach make an impact on the research experience. Consider Saumya Singh, an undergraduate who works in the wet lab on the UCSC iGEM team. She has previous research experience with Dr. David Deamer, a retired professor who works with just Singh and a graduate student.

“You really start to realize all the skills you’re reading about...can be applied. You realize how important your education is,” says Singh.

Singh mostly watched and trained for an entire quarter. She only began squeezing pipettes and cutting gels the quarter after. One can see the benefits of taking undergraduates in the lab, keeping talented students engaged and confident in their work, and also the time cost, an entire quarter of mentorship before she can dig into the primary research.

iGEM is a unique opportunity for inexperienced undergrads who can't find a break like Singh. Jovic and her co-leader Perez selected team members not just by experience, but how they work in a team and the earnestness of their commitment. Students like Jovic and Perez can make their own experience by taking on leadership roles, and make more opportunities for other undergraduates.

“It’s been awesome. You know, everyone makes mistakes once in a while, but we’re pretty open about that and you just learn from your mistakes,” says Jovic.

The opportunity at UCSC’s iGEM team also reached non-UCSC students. Jazel Hernandez comes from a community college, and hopes to one day work in biomedicine after watching several loved ones suffer from cancer. Community colleges often don’t have the resources for an immersive lab experience and cold calls to other schools can be hard, so Hernandez used a STEM class that focused on resume and abstract writing skills to make a strong application to the iGEM team.

Hernandez reports that help from peers in the lab has been invaluable, since Dr. Bernick cannot always be in the lab. In a survey of our iGEM team, several other lab members highlighted the difference peer relationships can make in a research experience. Peer to peer teaching can build confidence and leadership but negativity from competitive peers can be intimidating. These experiences highlight how important personality is to lab cohesion.

Like Jovic, Hernandez was previously rejected from a lab because she did not have enough experience. Her advice to other students looking for research: “You have to be very persistent. The more you push into something the more you get out...Hard work always pays off.”

Indeed, tenacity seems to be at the core of finding research and then thriving in research. However, Bernick points out that it is a disservice to not have research opportunities for even curious and persistent students.

“A public research university is put in place for two parallel reasons. One of them is research and developing science and developing the solutions that our society needs going forward. The other is teaching ... It’s very easy to forget that teaching is why we are paid,” says Bernick